IN THE UNITED STATES PATENT AND TRADEMARK OFFICE (DO/US)



International Application No. PCT/JP00/04199

International Filing Date: June 27, 2000

Title: Through Hole Conduction Structure Of Flexible Multilayer Circuit Board And Forming Method Thereof

Applicant for US: Kenichi HIRAHARA et al

**Attorney's Docket: KAM/133/PC/US**

Box PCT
Commissioner for Patents
Washington, DC 20231

Sir:

Please commence the United States National Processing of the above-identified international application.

**WE HEREBY REQUEST IMMEDIATE EXAMINATION UNDER 35 U.S.C. 317(f).**

The following items are enclosed:

(1) A check in the amount of $1,000.00 to cover the national fee, which has been calculated as follows:

| | |
|---|---|
| Basic fee (USPTO not ISA or IPEA 37 CFR § 1.492(a)(3)): | $1,000.00 |
| Independent claims in excess of 3 (0 x 80): | 0.00 |
| Claims in excess of 20 (0 x 18): | 0.00 |
| No multiple dependent claims presented: | 0.00 |
| Total: | $1,000.00 |

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# IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

International Application No. PCT/JP00/04199

International Filing Date: June 27, 2000

Title: THROUGH HOLE CONDUCTION STRUCTURE OF FLEXIBLE MULTILAYER CIRCUIT BOARD AND FORMING METHOD THEREOF

Applicants for US: Kenichi HIRAHARA
Kunihiko AZEYANAGI
Toshiyuki TSUKAHARA

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Washington, D.C. 20231

Sir:

## PRELIMINARY AMENDMENT

Prior to calculation of the filing fee and examination of the application, please enter the following amendments:

AMENDMENT

In the specification:

Page 1, after the title, insert the following heading and paragraph:

--Cross-Reference To Related Application

This is the U.S. national phase of International Application No. PCT/JP00/04199 filed June 27, 2000.--

Page 5, line 16, delete the first occurrence of the word "the".

Page 5, line 21, replace "1" with --11--.

The paragraph spanning lines 16-25 of page 5, after the above amendments should read as follows:

On both sides of the internal layer flexible circuit board, single-sided copper-clad laminates having the conduction layers 6 and 9 consisting of copper foils and the like are superimposed on the flexible insulating base materials 7 and 10 consisting of polymide films through adhesive layers 8 and 11 of the pre-preg to constitute respective external layer circuit boards each of which can be a mounting portion.

REMARKS

Applicant has amended the specification to reference the corresponding PCT application.

Page 5 of the specification has been amended to correct minor clerical errors.

Applicant requests that the amendments be entered prior to assessing the filing fee and examining the application.

Respectfully submitted,

Kenichi HIRAHARA et al

By

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SPECIFICATION

# Through Hole Conduction Structure of Flexible Multilayer Circuit Board and Forming Method Thereof

## TECHNICAL FIELD

The present invention relates to a through hole conduction structure of a flexible multilayer circuit board in which a high-density wiring is required and which has been worked out so as not to generate a crack in a through hole coating layer, and to a forming method thereof.

## BACKGROUND ART

Generally, in order to manufacture a multilayer circuit board, an adhesive or an adhesive resin layer called a pre-preg is used on both sides of an internal layer material to laminate and mold a copper-clad laminate. In particular, when laminating a thin multilayer circuit board such as a flexible multilayer circuit board, cover films consisting of, e.g., polyimide resin as an interlayer insulating material are attached on both sides of the internal layer material, and an external layer material is laminated on the obtained product through the adhesive or the pre-preg.

In such a flexible multilayer circuit board, after performing lamination and molding as described above, a through hole process is carried out at a required position of

the laminated circuit board and a through hole coating layer is formed in the through hole to attain conduction between the internal layer and the external layer.

However, since the cover film consisting of the polyimide resin has a high thermal expansion coefficient, it expands due to heat from the solder flow having a temperature of approximately 220°C at component mounting, and a crack is apt to be generated in the through hole coating layer. In the flexible multilayer circuit board in which a high-density wiring is required, this can be a serious problem as a product.

It is, therefore, an object of the present invention to provide a through hole conduction structure of a flexible multilayer circuit board in which a high-density wiring is required and which is configured so as not to generate a crack in a through hole coating layer, and to a forming method thereof.

DISCLOSURE OF THE INVENTION

To achieve this aim, the present invention provides a through hole conduction structure of a flexible multilayer circuit board comprising an internal layer circuit board which can be a cable portion, and an external layer circuit board which can be a component mounting portion laminated on one side or both sides of the internal layer circuit board at a predetermined position, wherein, in the flexible circuit board having a through hole plated conduction portion formed

at predetermined positions of the internal layer circuit board and the external layer circuit board, a surface protection layer formed on an external surface of a wiring pattern of the internal layer circuit board is formed in a region retreated toward the outside from a position of a through hole for the through hole plated conduction portion.

According to the above-described structure, it is possible to preferably eliminate a problem of generation of a crack in the through hole plated conduction portion in the prior art even if a polyimide resin cover film is used for the surface protection layer.

Further, as a forming method for that structure, it is possible to adopt a technique comprising the steps of: forming a required wiring pattern on one side or both sides of a flexible insulating base material; preparing an internal layer circuit board having a surface protection layer formed thereto on an external surface of the wiring pattern at a position retreated toward the outside from a position where a predetermined through hole is to be formed; laminating an external layer circuit board which can be a component mounting portion on one side or both sides of the internal layer circuit board in association with the position of the internal layer circuit board where the through hole is formed; forming a through hole at predetermined positions of the internal layer circuit board and the external layer circuit board; and forming a through hole plated conduction portion on the inner surface of the through hole.

Since the surface protection layer formed to the internal layer circuit board is provided at a position retreated toward the outside from a position where a predetermined through hole is formed, it is possible to preferably eliminate the adverse influence of thermal expansion on the through hole plated conduction portion even if the polyimide resin cover film is used for the surface protection layer.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a conceptual cross-sectional view of a primary part for explaining a through hole conduction structure of a flexible multilayer circuit board and a forming method thereof according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention will now be described in detail hereinafter with reference to an illustrative embodiment. Fig. 1 is a conceptual cross-sectional view of a primary part for explaining a through hole conduction structure of a flexible multilayer circuit board and a forming method thereof according to the present invention.

In the drawing, required wiring patterns 1 and 4 are formed on both sides of a flexible insulating base material 2 using, e.g., a polyimide film in the usual manner, and surface protection layers 3 and 5 consisting of polyimide films are formed on the external surfaces of the wiring

patterns 1 and 4. The inner edges portions of the surface protection layers 3 and 5, however, do not reach the inner wall of a through hole 13 and are provided at positions appropriately retreated from the position of the through hole 13 toward the outside. As an example, when a diameter of the through hole 13 is 0.3 mm, there are used surface protection layers 3 and 5 each of which has a hole of 0.7 mm formed thereto at a corresponding position.

The flexible insulating base material 2, the wiring patterns 1 and 4, and the surface protection layers 3 and 5 can constitute an internal layer flexible circuit board, and an illustrated part corresponds to a position for constituting a component mounting portion. The internal layer flexible circuit board extends from this part toward the outside as a cable portion.

On the both sides of the internal layer flexible circuit board, single-sided copper-clad laminates having the conduction layers 6 and 9 consisting of copper foils and the like are superimposed on the flexible insulating base materials 7 and 10 consisting of polyimide films through adhesive layers 8 and 1 of the pre-preg to constitute respective external layer circuit boards each of which can be a mounting portion.

Thereafter, upon forming a through hole 13 by NC drill means and the like, a through hole plated conduction portion 14 is formed by both using electroless plating means and electrolytic plating means, and a required wiring pattern

is formed to the conduction layer of each external layer circuit board, thereby constituting a hybrid flexible multilayer circuit board 14 having a component mounting portion.

In the above description, the polyimide double-sided copper-clad laminate having a copper foil with the thickness of 18 μm, an adhesive layer with the thickness of 18 μm and a polyimide layer with the thickness of 25 μm is used for the internal layer flexible circuit board, and the polyimide single-sided copper-clad laminate having a copper foil with the thickness of 18 μm, an adhesive layer with the thickness of 18 μm and a polyimide layer with the thickness of 25 μm is used for the external layer circuit board. Further, the pre-preg of 100 μm is used for each of the adhesive layers 8 and 11.

INDUSTRIAL APPLICABILITY

According to the through hole conduction structure of a flexible multilayer circuit board and a forming method thereof of the present invention, the surface protection layer formed on the external surface of the wiring pattern of the internal layer circuit board can be formed in a region retreated toward the outside from a position of the through hole for the through hole plated conduction portion. Therefore, even if the polyimide resin cover film as the surface protection layer for the wiring pattern expands due to heat from the solder flow, the risk of generation of a

crack and the like in the through hole plated conduction portion which has been observed in the prior art can be eliminated since the surface protection layer does not exist in the through hole region, thereby stably providing the highly reliable hybrid flexible multilayer circuit board in which the high-density wiring is required and the component mounting is enabled.

WHAT IS CLAIMED IS:

1. A through hole conduction structure of a flexible multilayer circuit board, comprising: an internal layer circuit board which can be a cable portion; and an external layer circuit board which can be a component mounting portion laminated on one side or both sides of said internal layer circuit board at a predetermined position, wherein, in said flexible multilayer circuit board having a through hole plated conduction portion formed at predetermined positions of said internal layer circuit board and said external layer circuit board, a surface protection layer formed on an external surface of a wiring pattern of said internal layer circuit board is formed in a region retreated toward the outside from a position of a through hole for the through hole plated conduction portion.

2. The through hole conduction structure of a flexible multilayer circuit board according to claim 1, wherein said surface protection layer is a cover film consisting of polyimide resin.

3. A method for forming a through hole conduction structure of a flexible multilayer circuit board comprising the steps of: forming a required wiring pattern on one side or both sides of a flexible insulating base material; preparing an internal layer circuit board having a surface protection layer formed thereto on an external surface of said wiring pattern at a position retreated toward the

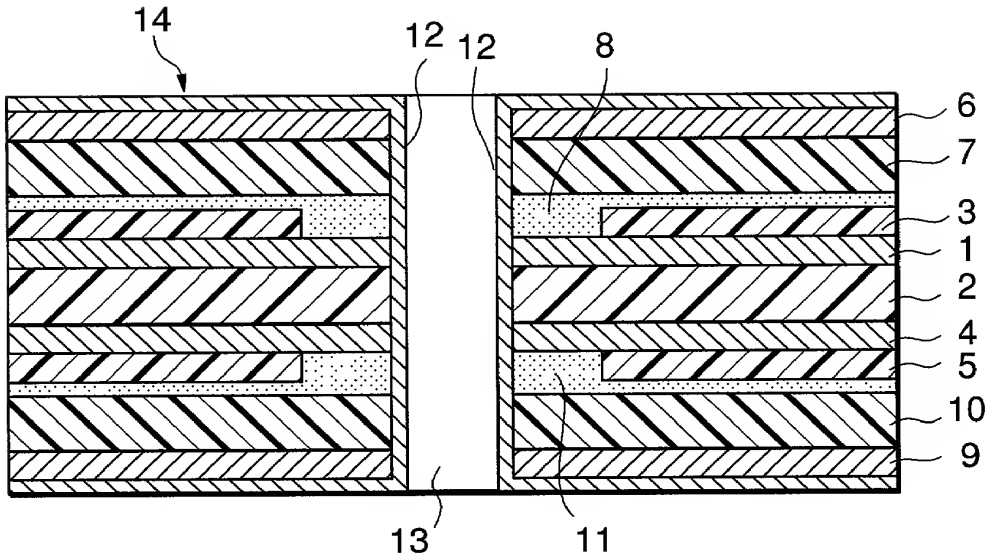
outside from a position where a predetermined through hole is to be formed; laminating an external layer circuit board which can be a component mounting portion on one side or both sides of said internal layer circuit board in association with a position of said internal layer circuit board where said through hole is formed; forming a through hole at predetermined positions of said internal layer circuit board and said external layer circuit board; and then forming a through hole plated conduction portion on an inner surface of said through hole.

4. The method for forming a through hole conduction structure of a flexible multilayer circuit board according to claim 3, wherein a cover film consisting of polyimide resin is used for said surface protection layer.

## ABSTRACT

In case of manufacturing a flexible multilayer circuit board which comprises an internal layer circuit board which can be a cable portion and an external layer circuit board which can be a component mounting portion laminated on one side or both sides of the internal layer circuit board at a predetermined position and which has a through hole plated conduction portion 12 formed at predetermined positions of the internal layer circuit board and the external layer circuit board, surface protection layers 3 and 5 formed on external surfaces of wiring patterns 1 and 4 of the internal layer circuit board are formed in a region retreated toward the outside from a position of a through hole 13 for a through hole plated conduction portion 12.

Fig .1



| 0010/PTO Rev. 6/95 | U.S. Department of Commerce Patent and Trademark Office | Attorney Docket Number | KAM/133/PC/US |
|---|---|---|---|
| | | First Named Inventor | Kenichi, HIRAHARA |
| **DECLARATION** | | *COMPLETE IF KNOWN* | |
| | | Application Number | |
| [X] Declaration Submitted with Initial Filing OR [ ] Declaration Submitted after Initial Filing | | Filing Date | |
| | | Group Art Unit | |
| | | Examiner Name | |

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Through Hole Conduction Structure of Flexible Multilayer Circuit Board and Forming Method Thereof

*(Title of the Invention)*

the specification of which

[ ] is attached hereto

OR

[X ] as filed on (MM/DD/YYYY) 06/27/2000 as United States Application or PCT International Application Number PCT/JP00/04199 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code §119 (a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

| Prior Foreign Application Number(s) | Country | Foreign Filing Date (MM/DD/YYYY) | Priority Not Claimed | Copy Attached? Yes | Copy Attached? No |
|---|---|---|---|---|---|
| 11-195312 | Japan | 07/09/1999 | [ ] | [ ] | [x] |
| | | | [ ] | [ ] | [ ] |
| | | | [ ] | [ ] | [ ] |
| | | | [ ] | [ ] | [ ] |

[ ] Additional foreign application numbers are listed on a supplemental priority sheet attached hereto:

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below:

| Application Number(s) | Filing Date (MM/DD/YYYY) | | |
|---|---|---|---|
| NONE | | [ ] | Additional provisional application numbers are listed on a supplemental priority sheet attached hereto. |

EL721435625US

# DECLARATION



I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

| U.S. Parent Application Number | PCT Parent Number | Parent Filing Date (MM/DD/YYYY) | Parent Patent Number *(if applicable)* |
|---|---|---|---|
| NONE | | | |

[ ] Additional U.S. or PCT international application numbers are listed on a supplemental priority sheet attached hereto.

As a named inventor, I hereby appoint the registered practitioners associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to that Customer Number:

Firm Name: Alix, Yale & Ristas, LLP  Customer Number: 002543

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

**Name of Sole or First Inventor**  [ ] A petition has been filed for this unsigned inventor

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|---|---|---|---|---|---|---|---|

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[X] Additional inventors are being named on supplemental sheet(s) attached hereto.

| DECLARATION | ADDITIONAL INVENTOR(S)<br>Supplemental Sheet |
|---|---|

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| Inventor's Signature | | | | Date | | | |
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| City | | State | | Zip | | Country | | Applicant Authority | |

**Name of Additional Joint Inventor, if any:** [ ] A petition has been filed for this unsigned inventor

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| Inventor's Signature | | | | Date | | | |
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**Name of Additional Joint Inventor, if any:** [ ] A petition has been filed for this unsigned inventor

| Given Name | | Middle Initial | | Family Name | | Suffix | |
|---|---|---|---|---|---|---|---|
| Inventor's Signature | | | | Date | | | |
| RESIDENCE: City | | State | | Country | | Citizenship | |
| POST OFFICE ADDRESS | | | | | | | |
| City | | State | | Zip | | Country | | Applicant Authority | |

[ ] Additional inventors are being named on supplemental sheet(s) attached hereto